SCH4R DEVELOPMENT OF ATOMIC THEORY - PART 2 WS-5

1. Which portion of the electromagnetic spectrum are we able to see?
   The portion of the electromagnetic spectrum which we are capable of detecting with our eyes is the visible portion. It is made up of the colours red, orange, green, blue, indigo and violet.

2. What is meant by the terms *continuous spectrum? Line spectrum?*
   A continuous spectrum is similar to a rainbow... the colours of light come one right after the other with no separation. A line spectrum on the other hand is a series of coloured lines... there are gaps between each observed line. The line spectrum of each element differs much like our fingerprints do.

3. What is believed to be the cause of the line spectrum for each element?
   Bohr reasoned that it was the electrons that were responsible for the line spectra. The different line spectra were thought to be due to the different number of electrons in each element. He came up with a mathematical model (beyond the scope of this course) that was capable of making predictions.

4. Rutherford's model was an improvement over Dalton/Thomson's model. Although it represented an improvement, it had some shortcomings (questions that it could not answer). Review these problems/questions (question 7 on WS-3).

   Bohr's model was seen as an improvement over Rutherford's. What problems/questions was Bohr able to address (take care of)?
   Rutherford's model could not explain why the electrons did not attract (move in) towards the nucleus. Bohr reasoned that, as electrons orbit the nucleus, the possess energy. As a planet orbits the sun, it too possesses energy. The planet is forever 'falling' into towards the sun; however, it has just the right speed to keep it at a constant distance. He argued that the electron behaves much in the same way as a planet does.

   Rutherford could not explain exactly where the electrons were nor how they were arranged about the nucleus. Bohr, with his mathematical model, was capable of indicating where the electrons were relative to the nucleus and how many electrons could exist in any given orbit at any one time.

   You shall also see, later, how his model is capable of providing an idea as to how compounds are formed.

5. In order for an electron to move to a higher orbit, what must happen to it?
   Remember, the higher one climbs, the more potential energy one acquires (gets). In order for an electron to move to a higher orbit, it must be given a boost of energy (it has to absorb or increase its energy).

6. What happens when the electron returns to a lower orbit?
   Upon returning to a lower orbit, the electron releases the energy that it originally absorbed. How much energy is released depends upon which orbit it drops down to.

7. Which transitions (jumps) were responsible for the visible lines seen in the line spectrum of hydrogen? Which transition gave rise to the violet line? The red line?
Bohr's mathematical calculations indicated that any jump from energy levels 6, 5, 4 and 3 down to energy level 2 released the right amount of energy that our eyes could detect. The transition responsible for the violet line was a jump from energy level 6 down to energy level 2; the colour red represents a smaller amount of energy... a jump from energy level 3 down to energy level 2 then is what produced the colour red.

8. People doubted Bohr's model at first as they thought he fudged a set of mathematical equations to 'fit' his model. The fact that he was able to make predictions using his model gave his model some credibility. Bohr predicted that a line spectrum would be visible in the infra-red region of the spectrum and was able to predict the exact frequencies of those lines. Which transitions, in his model, were responsible for the infra-red lines?
Infra-red energy is even smaller than that for red. This means then that the jumps must be even smaller than for red. His mathematical model indicated that the jumps (transitions) would be from energy levels 6 to 5, 6 to 4, 6 to 3, 5 to 4, 5 to 3 and 4 to 3. Indeed, when the technology was developed that enabled us to look into the infra-red region of the electromagnetic spectrum, the lines he predicted were there!!

9. Which transitions were responsible for the UV lines that Bohr predicted?
If you look at the electromagnetic spectrum, you will see that UV light represents a larger quantity of energy compared to visible light. In Bohr's model then, this means that the electrons would have to make larger jumps. Any combination of a jump from a level down to energy level 1 would result in UV light being produced. As above, when the technology was developed to enable us to look into the UV region, the lines that he predicted were there!!!!!

10. What is the maximum number of electrons permitted in the first energy level? 2^{nd}? 3^{rd}? 4^{th}? 5^{th}?
The maximum number of electrons permitted in any energy level is given by the formula $2n^2$. *Thus,*

    for energy level 1, n=1 and thus $2(1)^2 = 2$*.... 2 electrons are permitted*
    for energy level 2, n=2 and thus $2(2)^2 = 8$*.... 8 electrons are permitted*
    for energy level 3, n=3 and thus $2(3)^2 = 18$*...*

    for energy level 5, n=5... 50 electrons are permitted

11. Draw the Bohr atoms for Li, Na, K. What do they have in common?
If they were properly drawn, you would observed that the last orbit in each of these atoms has one electron in it.

12. Draw the Bohr atoms for O and S. What do they have in common?
Each of these elements has 6 electrons in its outermost orbit

13. Draw the Bohr atoms for Ne, Ar. What do they have in common?
Each of these elements has 8 electrons in its outermost orbit

14. Why was Bohr's model considered a failure?
Bohr's model was deemed to be a 'failure' for lack of a better word in the sense that it only worked (predicted the lines with great accuracy) for one electron systems (ex. For the hydrogen atom, the He^{+} atom, etc. As soon as multiple electrons came into the picture the accuracy disappeared.

15. Why is it that, although it is considered a failure, it is widely used in chemistry?
The modern, or quantum mechanical view of the atom, is better than Bohr's atom in that it can account for the shapes of the molecules as well as all which Bohr was able to explain. However, the mathematics behind this model and its complexity is even hard for students at the 4^{th} year of university!!

The simplicity of Bohr's model enables us to be able to understand the necessary chemical properties of matter at the highschool level.